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BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte RAJASHRI JOSHI, OLE HENRY DORUM,
and VIJAYA ISRANI

Appeal 2009-012098
Application 09/729,939
Technology Center 2100

Decided: May 11, 2010

Before JOHN A. JEFFERY, LEE E. BARRETT, and JEAN R. HOMERE, *Administrative Patent Judges*.

JEFFERY, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellants appeal under 35 U.S.C. § 134(a) from the Examiner's rejection of claims 1-37. We have jurisdiction under 35 U.S.C. § 6(b).[1] We reverse.

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[1] Appellants waived attendance at an oral hearing scheduled for May 4, 2010. *See* Oral Hearing Waiver Confirmation, filed Mar. 29, 2010.

STATEMENT OF THE CASE

Appellants invented a technique for representing geographic features using polynomial splines. For various geographic features, a processor generates a set of control points that define the spline. These control points can be used to compute the spline function which can represent a geographic feature in a map. Ultimately, the spline control points more efficiently represent map data in terms of storage requirements. *See generally* Spec. 1:8-9; 4:19-23; 5:27-31; Figs. 4-5.

Claim 1 is illustrative with the key disputed limitations emphasized:

> 1. A method for representing geographic features in a computer-based system, comprising:
>
> providing a first computer-usable database storing a plurality of data points specifying latitude and longitude coordinates of locations along at least one geographic feature;
>
> fitting a polynomial spline to the at least one geographic feature by applying a *least squares approximation* to the data points specifying latitude and longitude coordinates *to generate a plurality of control points for the polynomial spline*; and
>
> storing the control points in a second computer-usable database, the control points being usable for representing the geometry of the at least one geographic feature in the computer-based system.

The Examiner relies on the following as evidence of unpatentability:

Sennott	US 5,438,517	Aug. 1, 1995
Bargar	US 6,009,394	Dec. 28, 1999
Eberwine	US 6,133,867	Oct. 17, 2000

Rohm	US 6,253,164 B1	June 26, 2001
Dayanand	US 6,639,592 B1	Oct. 28, 2003

THE REJECTIONS

1. The Examiner rejected claims 1-3, 8-14, 16-27, 29-34, 36, and 37 under 35 U.S.C. § 103(a) as unpatentable over (1) Sennott and Bargar (Ans. 3-15)[2] or, alternatively, (2) Sennott and Eberwine (Ans. 18-31).
2. The Examiner rejected claims 4, 15, 28, and 35 under 35 U.S.C. § 103(a) as unpatentable over (1) Sennott, Bargar, and Dayanand (Ans. 15-17) or, alternatively, (2) Sennott, Eberwine, and Dayanand (Ans. 31-33).
3. The Examiner rejected claims 5-7 under 35 U.S.C. § 103(a) as unpatentable over (1) Sennott, Bargar, and Rohm (Ans. 17-18), or, alternatively, (2) Sennott, Eberwine, and Rohm (Ans. 33-34).

CONTENTIONS

Regarding independent claim 1, the Examiner finds that Sennott discloses a method for representing geographic features with every claimed feature except for fitting a polynomial spline to a geographic feature by applying a least squares approximation. Ans. 4, 35. The Examiner, however, cites Bargar for teaching this feature, and concludes that applying a least squares approximation to Sennott's polynomial spline (which is said

[2] Throughout this opinion, we refer to (1) the Appeal Brief filed December 9, 2008; (2) the Examiner's Answer mailed March 16, 2009; and (3) the Reply Brief filed May 15, 2009.

to be the "path" in Sennott) would have therefore been obvious. Ans. 4, 5, 35. In taking this position, the Examiner also equates points in Sennott's path to the recited "control points." Ans. 36.

The Examiner takes a similar position regarding the alternative secondary reference to Eberwine which, according to the Examiner, likewise teaches fitting a polynomial spline to a geographic feature by applying a least squares approximation. Ans. 18-19.

Appellants argue that Sennott and Bargar do not teach or suggest *applying a least squares approximation* to data points specifying latitude or longitude *to generate control points* for the polynomial spline as claimed. App. Br. 9-10; Reply Br. 3-4; emphases added. According to Appellants, the recited control points are not points located on a path that are represented by longitude or latitude as the Examiner asserts, but rather are computed to define the polynomial spline. Reply Br. 3. This distinction, Appellants contend, is evidenced by Appellants' Specification which defines a polynomial spline and control points. Reply Br. 3-4.

Appellants add that Bargar's genetic algorithm generates control points for the computed polynomial spline—not a least squares approximation as claimed. App. Br. 10-11. While Appellants acknowledge that Bargar applies a least squares error measure to solution splines, Appellants maintain that Bargar does not teach or suggest computing the control points for the spline using a least squares approximation. App. Br. 11; Reply Br. 4. Lastly, Appellants argue that Sennott and Bargar teach away from the claimed invention since their "robust fits" would allegedly not be achieved by the recited least squares approximation. App. Br. 11-12; Reply Br. 4.

Appellants make similar arguments regarding the alternative cited secondary reference to Eberwine. App. Br. 15-17. Regarding this rejection, Appellants emphasize that Eberwine applies a least squares approximation to fit a second-order polynomial equation—not to generate control points for a polynomial spline as claimed. App. Br. 15; Reply Br. 6.

The issue before us, then, is as follows:

ISSUE

Under § 103, has the Examiner erred in rejecting claim 1 by finding that Sennott and Bargar, or, alternatively, Sennott and Eberwine collectively would have taught or suggested fitting a polynomial spline to a geographic feature by applying a least squares approximation to data points specifying latitude or longitude to generate the spline's control points?

FINDINGS OF FACT (FF)

1. Appellants' shape point database 14 stores "shape points" and "nodes" that (1) represent geographic locations within a map, and (2) consist of coordinates including longitude and latitude. This database also stores "geographic feature entities" 17 (SEG) with associated nodes 23 (EN) and shape point entries 25 (SP). Spec. 4:24–5:17; Fig. 4.

2. For each geographic feature entity in Appellants' shape point database, processor 12 generates a set of control points and other parameters that define the spline. These control points and other parameters can be used to compute the spline function which can represent a geographic feature in a map. Ultimately, the spline control points more efficiently represent map data in terms of storage requirements. Spec. 4:19-23; 5:27-31; Figs. 4-5.

3. Appellants fit a least squares approximating polynomial spline to each geographic feature by applying a least squares approximation to the shape points and other parameters that define a particular geographic feature. This process generates the selected number of spline control points for each segment, which are then stored in spline database 16. Spec. 6-32; Figs. 4-5.

4. Sennott's system determines the position of an autonomous vehicle 102 in real time. As part of the vehicle's navigation system, the vehicle's route is defined including defining the route's nodes (e.g., road intersections) and segments (e.g., roads between intersections). Abstract; col. 50, ll. 5-52; Figs. 1, 3, 22.

5. Another route definition method fits B-splines to the driven data. B-splines describe the shape of a series of points by specifying the coefficients of a polynomial equation (i.e., an Nth order polynomial). Using polynomial splines to fit paths between objective points ensures continuous curvature and enhanced tracking performance. Sennott, col. 50, ll. 58-66; col. 51, ll. 23-25; col. 51, l. 68 – col. 52, l. 4; col. 56, ll. 5-27; Fig. 29.

6. Sennott also detects and extracts obstacles by (1) projecting the vehicle path into an image plane 3901 obtained via a scanner 3804; (2) transforming range data into height data; (3) fitting a curve to the height at the center of the road; (4) thresholding the actual road height against the height expectation; and (5) extracting the obstacles indicated by the differences in actual and expected road heights that exceed the threshold. Sennott, col. 69, l. 53; col. 71, l. 45 – col. 72, l. 5; Figs. 38A-B, 39.

7. To this end, Sennott models the road height by determining the height for every row 3908 in the image plane. A third order least squares curve is fit to these data. A height threshold is then referenced against the expected height as predicted by the third order fit to determine whether obstacles exist. Sennott, col. 72, ll. 30-55; Fig. 39.

8. Bargar describes using a "manifold interface" to translate high-dimensional representations into two or three dimensions (2D or 3D) (a "window space") so that the representations that can be understood and more readily manipulated by an observer. The 2D or 3D input signals are mapped back into the high-dimensional space ("phase space") to indicate positions and position changes in the high-dimensional space. Bargar, col. 2, ll. 3-16; col. 3, ll. 15-48; Fig. 1.

9. To this end, Bargar's manifold interface provides reference points ("generating points") to calibrate certain points in the "window space" 10 with points in the high-dimensional phase space 14. As shown in Figure 1, the window space defines how a 3D visual representation 12 is embedded in the high-dimensional phase space 14. Bargar, col. 4, l. 43 – col. 5, l. 6; Fig. 1.

10. Bargar applies a "genetic algorithm" (GA) to find the smooth connections between generating points. The GA then finds the smoothest possible manifold between these points. Bargar, col. 5, ll. 7-9.

11. In Figure 2, Bargar shows a technique to map points between the window and phase spaces 10, 14. To smooth out the map's "edges," high-dimensional splines are used, preferably cubic B-splines volumes built on a perturbation of the 3D lattice in the product of the phase and window spaces. Bargar, col. 5, ll. 45-67; Fig. 2.

12. Bargar provides two equations in connection with these B-splines: (1) an equation in lines 4-6 of column 6 that defines the B-spline curve by calculating p(u) for a given sequence of control points, and (2) an equation in lines 14-16 of column 6 that defines an associated B-spline volume by calculating p(u, v, w) for a given 3D lattice of control points. Bargar, col. 5, l. 67 – col. 6, l. 18.

13. Using a hardware device (e.g., a wand), an observer can draw traces 30 ("paths") in Bargar's window space 10. The paths are initially recorded as a set of (n+1)-tuples, points in the Cartesian produce of the n-dimensional phase space and one-dimensional time. Bargar, col. 6, ll. 34-55; Fig. 3.

14. This raw data is smoothed by approximating the original path through this (n+1)-space with a sequence of spline curves. This smoothing is done with a GA, where the bit vector representation of a sequence of spline segments is preferably a vector of fixed-point control points, and the fitness function approximates a least-squares error measure integrated over the original path. Bargar, col. 6, ll. 55-64; Fig. 3.

15. Eberwine discloses an aircraft collision avoidance system which processes GPS receiver and auto-pilot data. To this end, second-order polynomial coefficients pertaining to position, velocity, and acceleration are generated to accurately predict current and anticipated flight path. Eberwine, col. 1, ll. 10-22; col. 8, ll. 34-52; Fig. 3.

16. Eberwine's craft motion coefficients can be computed from consecutive position updates. For example, if a certain number of consecutive positions are maintained for a predetermined time period, then a second set of coefficients are calculated (i.e., using a least squares approximation). Eberwine, col. 10, ll. 1-21; Fig. 3.

17. As part of Eberwine's "watch radius" process, a list of consecutive position data is maintained for each remote object within a preprogrammed radius (i.e., watch radius). At each received remote object position update, a revised set of flight path coefficients is received or calculated for a polynomial to characterize the flight path. Eberwine, col. 14, ll. 21-26; Fig. 6.

18. To this end, if position data are received and coefficients are not received, a polynomial fit is applied to the position data (step 3210 labelled "Generate Coefficient" in Fig. 6) as a function of time. For example, this may be a cubic spline, quadratic, or least squares fit. Eberwine, col. 14, ll. 50-53; Fig. 6.

19. Appellants note that a polynomial spline space curve can be represented parametrically as a set of polynomial functions where the weights (P_i^x, P_i^y, P_i^z) on these spline basis functions are the spline's control points. Spec. 7:11-24.

20. The purpose of the least square fit in Appellants' invention is to find the optimal parametric polynomial spline curves to minimize the mean squared error between the curves and their respective longitude, latitude, and altitude bearing values. To this end, Appellants' invention finds an appropriate set of control points. Spec. 8:26-29; 10:14-16.

PRINCIPLES OF LAW

During patent examination, claims are given their broadest reasonable interpretation in light of the Specification as it would be interpreted by skilled artisans. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1316 (Fed. Cir. 2005) (en banc) (citations omitted). This interpretation, however, must not import limitations from the Specification into the claims. *See id.* at 1323.

ANALYSIS

We begin by noting that it is undisputed that Sennott, Bargar, and Eberwine discuss polynomial splines in connection with their respective methods. These references all but confirm this point, for Sennott's vehicle route definition method uses polynomial splines to fit paths between points to ensure continuous curvature (FF 5), and Bargar uses high-dimensional splines to smooth mapped points between lower- and higher-dimensional spaces (FF 11-12). Eberwine likewise contemplates using a cubic spline in connection with generating coefficients for a polynomial. FF 18.

Rather, the dispute before us hinges on whether the cited prior art would have taught or suggested how to generate the *control points* of such a spline, namely by *applying a least squares approximation* to data points specifying longitude and latitude coordinates as claimed.

To resolve this issue, we first construe the term "control points" as it pertains to a polynomial spline—a crucial determination in this appeal, particularly since both Appellants and the Examiner construe this term quite differently. The Examiner apparently takes the position that the "control points" of Sennott's spline are "points disclosed *in the path*." *See* Ans. 36 ("[T]he points disclosed *in the path* [in Sennott] (*control points*) can be

latitude and longitude . . . .") (emphases added). Appellants, however, emphasize that a polynomial spline's control points are not located on the path as the Examiner asserts, but rather are *computed to define the spline* as evidenced by the definitions in the Specification. Reply Br. 3-4 (emphasis added).

We agree with Appellants. Appellants' Specification notes that particular "geographic feature entities" have associated "shape points" and "nodes" that (1) represent geographic locations within a map, and (2) consist of coordinates including longitude and latitude. FF 1. Notably, a processor uses these "shape points" and other parameters to generate a selected number of polynomial spline "control points," namely by applying a least squares approximation to the shape points and other parameters. FF 3. These computed control points can then be used to compute the spline function which can represent a geographic feature in a map. FF 2. Notably, using a least squares approximation in this determination is crucial since it optimizes the parametric polynomial spline curves by minimizing mean squared error. *See* FF 19-20.

Construing the recited "control points" in light of this description, *see Phillips*, 415 F.3d at 1316, we find that the recited "control points" are not merely points in a path as the Examiner asserts (Ans. 36), but rather are computed data values that define the polynomial spline itself. The Examiner's reference to Sennott's points in a path (*id.*) is actually more germane to Appellants' "shape points"—points to which a least squares approximation is applied to generate the spline's control points. *See* FF 2.

While Sennott uses (1) polynomial splines to fit paths between points to ensure continuous curvature (FF 5), and (2) third-order least-squares curve fitting in connection with modeling road height in an obstacle detection and extraction process (FF 6-7), there is simply nothing in Sennott that would have taught or suggested *generating the splines' control points* by applying the recited least squares approximation.

Nor does Bargar cure this deficiency. Although the Examiner cites Bargar for teaching applying a least squares approximation *to a polynomial spline* (Ans. 4, 35, 36) (emphasis added), the claim, however, requires applying the least squares approximation *to data points* representing latitude and longitude *to generate the spline's control points*.

To be sure, Bargar discloses a smoothing technique in a high-level mapping process involving a "genetic algorithm" and polynomial splines (FF 10-14)—an algorithm which Appellants admit generates the spline's control points.[3]

But Bargar does not indicate that the genetic algorithm (or any other aspect of Bargar for that matter) *applies a least squares approximation* to the data points specifying longitude or latitude to generate these control points. Although Bargar refers to a least squares approximation, it is with respect to an error measure integrated over the original path (FF 14)—not for generating the spline's control points. Notably, Bargar's two B-spline equations in column six both indicate that the associated control points are "given," but do not elaborate how these control points are determined. *See*

[3] *See* Reply Br. 4 ("Barger discloses using a least squares error measure to evaluate the computed polynomial spline *whose control points were generated using a genetic algorithm.*") (emphasis added).

FF 12. On this record, we cannot say that these control points would have been generated using a *least squares approximation*, let alone that such an approximation would have been applied to data points specifying longitude or latitude to achieve that end.

We reach a similar conclusion regarding the cited alternative secondary reference to Eberwine. Although Eberwine computes second-order polynomial coefficients for craft motion using a least squares approximation (FF 16), we cannot say that this technique would have been reasonably applied to generating control points for a polynomial *spline* as claimed.

Nor can we say that a least squares approximation would be used to generate control points for the cubic spline mentioned in connection with the polynomial used to characterize the flight path in Eberwine. *See* FF 18. While this spline may be used to generate these flight path coefficients, that hardly means that a least squares approximation is used to generate the control points for the spline itself. Although Eberwine does mention that both a cubic spline or a least squares fit can be used to generate flight path coefficients, they are listed *in the alternative*. FF 18 (listing exemplary alternatives which may be "a cubic spline, quadratic, *or* least squares fit") (emphasis added). As Appellants indicate (App. Br. 16), nothing in Eberwine indicates that a cubic spline and a least squares fit technique can be used together. But even if they could, there is still nothing on this record indicating that such a least squares fit technique could or would be used to *generate the spline's control points* as claimed.

We are therefore persuaded that the Examiner erred in rejecting independent claim 1 over Sennott and Bargar, or, alternatively, Sennott and Eberwine. We reach a similar conclusion regarding independent claims 14, 16, 23, and 29 which recite commensurate limitations.[4] We also reverse the Examiner's rejection of dependent claims 2, 3, 8-13, 17-22, 24-27, 30-34, 36, and 37 over these references for similar reasons.

Moreover, since the Examiner has not shown that the additional cited references to Dayanand and Rohm cure the above-noted deficiencies, we also reverse the Examiner's rejections of claims 4-7, 15, 28, and 35 based on these references combined with Sennott and Bargar or, alteratively, Sennott and Eberwine.

[4] Although Appellants raise for the first time in the Reply Brief a separate argument that combining Sennott with Eberwine would allegedly render Sennott unsatisfactory for its intended purpose (Reply Br. 6-7), we decline to address those arguments since they were not timely raised and are therefore waived. *See Ex parte Borden*, 93 USPQ2d 1473, 1474 (BPAI 2010) (informative) ("[The reply brief [is not] an opportunity to make arguments that could have been made in the principal brief on appeal to rebut the Examiner's rejections, but were not."). But even if this argument were timely raised, we nevertheless need not address it since the other noted deficiencies of the rejection are dispositive of this appeal.

CONCLUSION

The Examiner erred in rejecting claims 1-37 under § 103.

ORDER

The Examiner's decision rejecting claims 1-37 is reversed.

REVERSED

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